OFCM

FEDERAL METEOROLOGICAL HANDBOOK NO. 11

DOPPLER RADAR METEOROLOGICAL OBSERVATIONS

PART A
SYSTEM CONCEPTS, RESPONSIBILITIES, AND PROCEDURES

FCM-H11A-2006

WSR-88D

Washington, DC
April 2006

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METEOROLOGICAL SERVICES AND SUPPORTING RESEARCH

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PREFACE

The Federal Coordinator for Meteorological Services and Supporting Research has the responsibility to maintain and publish Federal Meteorological Handbooks. This series of documents provides standards and procedures to facilitate the efficient collection, sharing, and use of meteorological information by agencies of the federal government and private industry.

The original Federal Meteorological Handbook, Number 11 (FMH-11), DOPPLER RADAR METEOROLOGICAL OBSERVATIONS, was prepared and published under the auspices of the Office of the Federal Coordinator for Meteorological Services and Supporting Research (OFCM) at the request of the Next Generation Weather Radar (NEXRAD) Program Council and in coordination with the federal agencies that are represented on the Interdepartmental Committee for Meteorological Services and Supporting Research. The purpose of FMH-11 is to standardize, insofar as practical, the operation of the Weather Surveillance Radar-1988, Doppler (WSR-88D) systems and the procedures used by personnel of the Departments of Commerce, Defense, and Transportation. By approving publication of this handbook, those agencies have agreed to operate their WSR-88D systems accordingly. Some flexibility under certain meteorological, siting, or mission circumstances is permitted to enhance the quality and utility of some WSR-88D products.

The revision process is dependent on the evolution of WSR-88D subsystems hardware, software, and products. Part A has been revised in conjunction with recent WSR-88D software releases to ensure it provides users current operations guidance. Parts B, C, and D have/are being revised in a separate effort principally through the guidance of the WSR-88D Radar Operations Center (ROC). All revisions are coordinated among the NEXRAD triagencies (Department of Commerce (DOC), Department of Defense (DoD), and Department of Transportation (DOT)); thus, they possess the same authority as the initial edition of FMH-11.

The agencies should review the documents annually. The goal is to review and update the handbooks (as necessary) as part of every WSR-88D software build release. Suggestions for modifications and additions should be sent to the WSR-88D Radar Operations Center webmaster at http://www.roc.noaa.gov/Feedback/ for consideration for inclusion in a future update. As required, the handbooks will be updated and published in electronic format, and made available on the OFCM home page at http://www.ofcm.gov/homepage/text/pubs.htm. Readers can make copies of the handbooks without a request for approval from the OFCM. A summary of changes made during updates will be annotated in the preface of each part.

In all, FMH-11 has four parts:

Part A - System Concepts, Responsibilities, and Procedures (April 2006)

Part B - Doppler Radar Theory and Meteorology (December 2005)

Part C - WSR-88D Products and Algorithms (Expected in 2006)

Part D - WSR-88D Systems Description and Operational Applications (February 2006)

Part A provides an introduction for the entire handbook including the restatement of some policy, definitions of terms, and agencies' functions and responsibilities under the WSR-88D System Concept. It provides listings of the location of systems and products the WSR-88D can generate and information on the modes of operation, volume coverage patterns, and levels of data archival. Additionally, authority for change to adaptation parameters is established. Familiarity with Part A should aid the user of other parts of FMH-11 and provide a better understanding of the overall WSR-88D system.

Summary of Major Changes:
This version of Part A replaces the December 2005 version. This version updates the document as of Radar Product Generator and Radar Data Acquisition Build 8 (released in May 2006) and the legacy Radar Data Acquisition System Build 10. This version updates the operational mode selection that changed in Build 8, the list of products (a product is added in Build 8, Archive III Status Product), and the tower height information based on Global Positioning System data at 29 sites. Minor errors in the previous version have also been corrected. In addition, this update introduces the authority for Unit Radar Committees to change the default precipitation volume coverage pattern and to set the Mode Selection Function to enable an automatic switching of the radar back to Clear Air Mode.

Samuel P. Williamson
Federal Coordinator for Meteorological
 Services and Supporting Research

FEDERAL METEOROLOGICAL HANDBOOK NO. 11
DOPPLER RADAR METEOROLOGICAL OBSERVATIONS

PART A
SYSTEM CONCEPTS, RESPONSIBILITIES, AND PROCEDURES

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Definition of Terms

WSR-88D System. A WSR-88D system is composed of a Weather Surveillance Radar - 1988, Doppler and communications links to distribute products to various agency display systems. The functional designations are: Radar Data Acquisition system, Radar Product Generator, and agency user display systems.

Agency User Display Systems. The agencies have various user display systems with dedicated and/or dial connections to WSR-88Ds. The current list of display systems is:

> **Principal User Processor (PUP)**. The original display system fielded with the WSR-88D. Currently, PUPs are only used at some Department of Defense (DoD) locations.

> **Open Principal User Processor (OPUP)**. This DoD display system is fielded in three sizes: small, medium, and large.

> **Advanced Weather Interactive Processing System (AWIPS)**. The National Weather Service (NWS) operates AWIPS at each Weather Forecast Office to integrate and display data and products from all sources.

> **Weather and Radar Processor (WARP)**. The WARP is the Federal Aviation Administration's (FAA's) computer network that places WSR-88D product data on air controllers' displays in Air Route Traffic Control Centers (ARTCCs). The WARP also collects, formats, and distributes weather information to Center Weather Service Units at FAA ARTCCs.

> **Integrated Terminal Weather System**. This FAA system integrates data from the WSR-88D, Terminal Doppler Weather Radar, Airport Surveillance Radar-9, Low-level Wind Shear Alert Systems, Automated Surface Observing Systems, and other NWS systems.

> **Medium Intensity Airport Weather System**. This FAA system is at three airports that have a medium intensity of aircraft operations.

> **Micro Enroute Air Route Traffic System**. This FAA system is located at Combined Center/Radar Approach Control outside the conterminous United States (CONUS).

National Weather Radar Network. The national weather radar network consists of sites dispersed throughout the CONUS.

Network Site. A Network Site is a Department of Commerce WSR-88D site in the CONUS.

Supplemental Site. A Supplemental Site is a DoD site in the CONUS.

Non-Network Site. A non-Network Site is a non-CONUS DoD site or a non-CONUS Department of Transportation site.

Principal User. Principal users are the National Oceanic and Atmospheric Administration's NWS, the Air Force, the Marine Corps Weather Service, and the FAA.

>   **Associated Principal User.** An associated principal user is a principal user linked to a WSR-88D system with a dedicated telecommunication line.
>
>   **Non-Associated Principal User.** A non-associated principal user is a principal user with access to a WSR-88D system through means of dial telecommunication.

External User. An external user is anyone other than a principal user who uses WSR-88D data and products (e.g., information service companies, broadcast meteorologists, aviation interests, marine interests, industrial meteorologists, other government agencies, and universities).

CHAPTER 1

BACKGROUND

1.1 <u>Introduction</u>. The impetus for originally preparing this handbook was the development, acquisition, and deployment of the Weather Surveillance Radar - 1988, Doppler (WSR-88D). The motivation for this update is to reflect the changing operation of the WSR-88D system as it matures.

The Federal Coordinator for Meteorological Services and Supporting Research determined that the preparation of this handbook was required to support triagency use of the WSR-88D. Subsequent to coordination within the Interdepartmental Committee for Meteorological Services and Supporting Research, a Doppler Radar Meteorological Observations Working Group (WG/DRMO) was formed within the Committee for Basic Services. The WG/DRMO was charged with the responsibility for preparation of the Federal Meteorological Handbook, Number 11, FMH-11, this handbook.

The WG/DRMO was composed of personnel from the National Weather Service (NWS) within the Department of Commerce (DOC), the Air Force Weather Agency and the Marine Corps within the Department of Defense (DoD), and the Federal Aviation Administration (FAA) within the Department of Transportation (DOT). This version has been coordinated with the triagency WSR-88D focal points and triagency WSR-88D Radar Operations Center (ROC) personnel.

1.2 <u>Purpose and Scope</u>. This handbook provides information, guidance, and instruction regarding the triagency management and operation of the WSR-88D systems. The following definitions apply throughout this handbook:

> Shall: means that a procedure or practice is mandatory.
> Should: means that a procedure or practice is recommended.
> May: means that a procedure or practice is optional.
> Will: means futurity, not a requirement to be applied to a procedure or practice.

1.3 <u>Policy</u>. The WSR-88D systems shall be operated to satisfy the integrated set of federal requirements that emanated primarily from the public charters of the departments represented in the Next Generation Weather Radar (NEXRAD) Program Council (NPC) and the NEXRAD Program Management Committee (NPMC). This handbook has been developed to establish standards for the triagency operation of the WSR-88D systems and the collection, processing, and dissemination of information to meet those requirements. As a federal system, it shall be operated to meet as many requirements as possible. However, this handbook guides operations to fulfill first those fundamental requirements of the agencies that founded the program. Policy, procedures, and operational concepts, as defined in this handbook, shall be adhered to by the

principal user agencies.

1.4 <u>Changes</u>. NEXRAD agency user suggestions for modifications and additions shall be forwarded through the appropriate channels in each agency for consideration, and issuance, if appropriate.   No modification shall be adopted that adversely impacts fulfillment of the integrated requirements that drove the development of the program without the consent of the NPC. (The NPC has delegated this responsibility to the NPMC.)

CHAPTER 2

WSR-88D SYSTEM CONCEPT

2.1 <u>Overview of Agency Functions.</u>   The following sections provide discussions of each principal user agency's functions with regard to WSR-88D system operations.

      2.1.1 Department of Commerce. Within the DOC, the National Oceanic and Atmospheric Administration's (NOAA) NWS is the civilian weather agency of the Federal Government.   As such, it must fill a broad spectrum of climatological, meteorological and hydrological requirements in its efforts to protect life and property and support the economy of the United States (US). Specifically, the NWS is responsible for the detection and public warning of hazardous weather such as tornadoes, severe thunderstorms, hurricanes, floods, flash floods, winter storms, damaging tides, and any other meteorological or hydrological event with possible harmful effects.   The NWS provides weather information for marine operations covering offshore, coastal, Great Lakes, and river and harbor areas for both commercial and recreational activities. The NWS also routinely provides forecasts for civilian aviation, reservoir regulation, wild land fire fighting agencies, and a variety of commercial activities.   To assist in fulfilling these responsibilities, the NWS operates the national weather radar network and uses information from DoD and DOT WSR-88D systems.

      2.1.2 Department of Defense.   Within the DoD, the U.S. Air Force provides worldwide meteorological and aerospace environmental services to the Air Force, Army, and certain other DoD elements; and the Marine Corps Weather Service units provide environmental support to U.S. Marine Corps activities and operations. These organizations are responsible for providing and relaying severe weather warnings for the protection of DoD resources and personnel, managing flood control reservoirs (U.S. Army Corps of Engineers), providing meteorological and space environmental information to aid the decision-making process at all levels of command authority, and supporting military aerospace operations.   To meet these responsibilities, DoD operates WSR-88D systems in the United States and overseas and uses information from the DOC and DOT WSR-88D systems.

      2.1.3 Department of Transportation.   The DOT, through the FAA, is responsible for the safe and efficient utilization of the National Airspace System. In meeting this responsibility, DOT disseminates information on the location and intensity of potentially hazardous weather conditions to pilots, air traffic controllers, air traffic flow management, and others concerned with aviation.   The DOT obtains and processes data from DOC, DoD, and DOT WSR-88D systems for use by DOT personnel and DOC personnel located in DOT facilities.

2.2 <u>System Support Management.</u> Operational support for the deployed WSR-88D system is provided by the ROC, located in Norman, Oklahoma.   The ROC provides centralized management, coordination, and control for the comprehensive life cycle support of WSR-88D systems. The ROC performs systematic and coordinated analyses of the day-to-day operations

and maintenance of WSR-88D systems to determine the need for improvement and provides both immediate and long-term support during the WSR-88D life cycle.

2.3 <u>Memorandum of Agreement for the Interagency Operation of the WSR-88D.</u> Policies, procedures, and operational concepts, as defined in this handbook, have been agreed to by each principal user agency. Each agency shall endeavor to support, to the highest degree possible and in accordance with the terms of the Memorandum of Agreement (MOA) for the Interagency Operation of the WSR-88D, the data, product, and operational requirements of the other agencies. This supportive service shall be consistent with the capabilities and mission priorities of the agency that has received the request for support. The MOA also forms the basis for the membership, leadership, and activities of the Unit Radar Committee (URC) that shall be at each WSR-88D site where more than one NEXRAD agency is connected. The MOA is available at: http://www.roc.noaa.gov/PDFs/MOA.pdf.

2.4 <u>External User Access to WSR-88D Products and Level II Data.</u> Real-time access to products and Level II data can be achieved through two networks the NWS manages: (1) Products can be obtained through the NWS' Radar Product Central Collection Dissemination Service (RPCCDS); and (2) Level II data can be obtained through the NWS' Level II Data Collection and Distribution Network.

   2.4.1 Products. The RPCCDS replaced the NEXRAD Information Dissemination Service agreement in January 2000. The RPCCDS makes a predefined subset of all WSR-88D products available in near real time from every WSR-88D in the CONUS and all but four remote DoD non-CONUS locations (Lajes Air Base (AB), Kadena AB, Camp Humphreys, and Kunsan AB) available to external users. Users are able to connect to the RPCCDS via a dedicated connection or file transfer protocol. In addition, a predetermined set of products are provided to NOAAPORT users. Additional RPCCDS information is available at: http://www.nws.noaa.gov/tg/rpccds.html. A predetermined subset of the images available from each WSR-88D is available at: http://weather.noaa.gov/radar/national.html. Non-NEXRAD agency connections to individual radar sites are not permitted.

   2.4.2 Level II Data. The principal user agencies offer direct access to Level II data from operational sites on a limited basis to support government operations at sites where the required interface hardware is installed. Only certified systems will be permitted to connect to radars and only with advance triagency approval. The NWS has established a WSR-88D Level II Data Collection and Distribution Network. The network includes all NWS radars (121) and 13 CONUS DoD radars, though more sites may be added. These data are available in near real time from many sources and can be used or redistributed without any restriction. Information on the network is available at: http://www.roc.noaa.gov/NWS_Level_2/.

2.5 <u>National Centers' Applications.</u> The national centers of the NWS, Air Force, and FAA have agency-specific display platforms to acquire and display real-time WSR-88D data for their agency-specific applications. Several dial ports per Radar Product Generator (RPG) are allocated

for national centers' access. National centers may require information to suit a wide range of missions that assist decision making in support of critical operations and exercises. The FAA's center has access to Doppler weather radar information from a variety of sources to support its management of aviation traffic flow. The national centers are: Storm Prediction Center, Tropical Prediction Center, Marine Prediction Center, Aviation Weather Center, Hydrometeorological Prediction Center, Air Force CONUS and Pacific Operational Weather Squadrons, River Forecast Centers, and the Air Traffic Control Systems Command Center.

CHAPTER 3

SITE RESPONSIBILITIES

3.1 <u>Introduction</u>. The WSR-88D system is vital to the operation of each principal user agency. Therefore, WSR-88D systems shall be operated to satisfy the integrated needs of all three agencies. Each agency shall endeavor to support, to the maximum extent possible, the data, products, and operational requirements of the others, consistent with the capabilities and mission priorities of that agency. The units shall be operated in accordance with the procedures described in this handbook and as agreed to by the URC within the terms of the MOA for the Interagency Operation of the WSR-88D. The weather forecast office (WFO), base weather station or operational weather squadron that is the manager of the Master System Control Function (MSCF) chairs the URC (Tables 3-1 through 3-4).

WSR-88D sites are categorized as Network, Supplemental, or non-Network. Tables 3-1 through 3-4 list the metropolitan areas served by each system. In addition, the WSR-88D system four-letter International Civil Aviation Organization (ICAO) identifier; name of RDA system location; and RDA antenna elevation in feet above mean sea level (MSL); are specified for each system. Table 3-5 shows how the antenna elevation above MSL is computed (including the updates contained in the RPG Build 8 software).

3.2 <u>Network Site Responsibilities</u>. A WSR-88D Network Site (Table 3-1) shall:

- Operate continuously, 24 hours per day, and collect, collate and make available via telecommunications, radar data and products in support of the national weather radar network. This support shall be performed in accordance with the policies described in this handbook and such agreements as may be made among the principal users, including the MOA for Interagency Operation of the WSR-88D. A copy of the MOA may be obtained at: http://www.roc.noaa.gov/PDFs/MOA.pdf.
- Use one of the operational modes and volume coverage patterns (VCPs) agreed to by the URC.
- Set the default precipitation VCP as agreed to by the URC.
- Set the Mode Selection Function to switch the RPG Mode to Clear Air Mode (i.e., to a Clear Air VCP) and to switch from Clear Air to Precipitation Mode as agreed to by the URC.
- Generate and distribute WSR-88D products as specified by *WSR-88D Operator Handbook, Guidance on Adaptable Parameters-RPG.* The handbook can be obtained at: http://www.roc.noaa.gov/ssb/sysdoc/Operations.asp.
- Use appropriate levels of clutter filtering to reduce ground clutter and anomalous propagation (AP) for the WSR-88D systems the WFOs control via the MSCF (Tables 3-1 through 3-4).

3.3 <u>Supplemental Site Responsibilities.</u> A WSR-88D Supplemental Site (Table 3-2) shall:

- Operate continuously, 24 hours per day, and collect, collate, and make available via telecommunications, radar data and products in support of the DoD. This support shall be performed in accordance with the policies described in this handbook and such agreements as may be made among the principal users, including the MOA for Interagency Operation of the WSR-88D. A copy of the MOA may be obtained at: http://www.roc.noaa.gov/PDFs/MOA.pdf.
- Use one of the operational modes and VCPs agreed to by the URC.
- At Vandenberg AFB, set the default precipitation VCP as agreed to by the URC.
- At Vandenberg AFB, set the Mode Selection Function to switch the RPG Mode to Clear Air Mode (i.e., to a Clear Air VCP) and to switch from Clear Air to Precipitation Mode as agreed to by the URC.
- Provide assistance to NWS weather forecast offices (WFOs) and the FAA by providing access to weather radar data to reduce gaps in the national weather radar network. Ensure the provision of radar data is consistent with responsibilities stated in the MOA for Interagency Operation of the WSR-88D.
- Generate and distribute WSR-88D products as specified by WSR-88D Operator Handbook, Guidance on Adaptable Parameters-RPG. The handbook can be obtained at: http://www.roc.noaa.gov/ssb/sysdoc/Operations.asp.
- Use appropriate levels of clutter filtering to reduce ground clutter and AP for the WSR-88D systems the DoD controls via the MSCF (Table 3-2).
- Maintain an Implementing Agreement (IA) with the NWS WFO controlling the MSCF (where applicable) regarding the WSR-88D maintenance. The DoD maintenance organization will initiate and maintain the IA. The IA template can be obtained from the DoD WSR-88D focal point listed in Appendix B of the MOA for Interagency Operation of the WSR-88D (http://www.roc.noaa.gov/PDFs/MOA.pdf).

3.4 <u>Non-Network Site Responsibilities.</u>

A DOT non-CONUS Site (Table 3-3) shall:

- Operate continuously, 24 hours per day, and collect, collate, and make available via telecommunications, radar data and products in support of FAA's enroute weather radar coverage, DoD's and NWS's operations. This support shall be performed in accordance with the policies described in this handbook and such agreements as may be made among the principal users, including the MOA for Interagency Operation of the WSR-88D. A copy of the MOA may be obtained at: http://www.roc.noaa.gov/PDFs/MOA.pdf.
- Use one of the operational modes and VCPs agreed to by the URC.
- Generate and distribute WSR-88D products as specified by WSR-88D Operator Handbook, Guidance on Adaptable Parameters-RPG. The handbook can be obtained at: http://www.roc.noaa.gov/ssb/sysdoc/Operations.asp.

A DoD non-CONUS Site (Table 3-4) shall:

- Operate continuously, 24 hours per day, and collect, collate, and make available via narrowband communications, radar data and products in support of the DoD. This support shall be performed in accordance with the policies described in this handbook and such agreements as may be made among the principal users, including the MOA for Interagency Operation of the WSR-88D. A copy of the MOA may be obtained at: http://www.roc.noaa.gov/PDFs/MOA.pdf.
- Use one of the operational modes and VCPs agreed to by the URC.
- Set the default precipitation VCP as agreed to by the URC.
- Set the Mode Selection Function to switch the RPG Mode to Clear Air Mode (i.e., to a Clear Air VCP) and to switch from Clear Air to Precipitation Mode as agreed to by the URC.
- Generate and distribute WSR-88D products as specified by WSR-88D Operator Handbook, Guidance on Adaptable Parameters-RPG. The handbook can be obtained at: http://www.roc.noaa.gov/ssb/sysdoc/Operations.asp.
- Use appropriate levels of clutter filtering to reduce ground clutter and AP for the WSR-88D systems the DoD controls via the MSCF (Table 3-4).
- Maintain an IA with the NWS WFO controlling the MSCF (where applicable) regarding the WSR-88D maintenance. The DoD maintenance organization will initiate and maintain the IA. The IA template can be obtained from the DoD WSR-88D focal point listed in Appendix B of the MOA for Interagency Operation of the WSR-88D (http://www.roc.noaa.gov/PDFs/MOA.pdf).

TABLE 3-1
NETWORK SITES

Metropolitan Area	Radar ICAO	RDA System Location	Antenna Elev. (Ft) MSL
AL, Birmingham	KBMX	Alabaster, AL	759
AL, Mobile	KMOB	Mobile Regional Airport	289
AL, Northeast AL	KHTX	Hytop, AL	1,860
AR, Western AR	KSRX	Chaffee Ridge, AR **	721
AR, Little Rock	KLZK	N. Little Rock Municipal Airport	649
AZ, Flagstaff	KFSX *	Flagstaff, AZ	7,515
AZ, Phoenix	KIWA	Phoenix, AZ	1,418
AZ, Tucson	KEMX	Tucson, AZ	5,319
AZ, Yuma	KYUX *	Yuma, AZ **	237
CA, Santa Ana Mts.	KSOX	Santa Ana Mtns: Beeks Place**	3,092
CA, Eureka	KBHX	Bunker Hill: Humboldt Cnty	2,516
CA, Los Angeles	KVTX	Sulphur Mtn.: Ventura Cnty	2,807
CA, Sacramento	KDAX	USAF Davis: Sacramento, CA	144
CA, San Diego	KNKX	Miramar Naval Air Station	1,052
CA, San Francisco	KMUX	Los Gatos, CA	3,550
CA, San Joaquin	KHNX	Hanford Municipal Airport	341
CO, Denver	KFTG	Front Range Airport	5,611
CO, Grand Junction	KGJX*	Grand Mesa: Mesa, CO	10,098
CO, Pueblo	KPUX	Pueblo, CO	5,362
FL, Jacksonville	KJAX	Jacksonville Intl. Airport	160
FL, Key West	KBYX	Boca Chica Key, FL	89
FL, Melbourne	KMLB	Melbourne Regional Airport	116
FL, Miami	KAMX	Richmond Heights	112
FL, Tallahassee	KTLH	Tallahassee Regional Airport	177
FL, Tampa Bay Area	KTBW	Ruskin, FL	122

* - Redundant Radar Data Acquisition (RDA), ** Western AR MSCF at Tulsa, OK WFO; Yuma MSCF at Phoenix, AZ WFO; Santa Ana Mtns MSCF at San Diego, CA WFO

TABLE 3-1
NETWORK SITES

Metropolitan Area	Radar ICAO	RDA System Location	Antenna Elev. (Ft) MSL
GA, Atlanta	KFFC	Peachtree City, GA	972
IA, Des Moines	KDMX	Johnston, IA	1,095
IA, Quad Cities	KDVN	Davenport Municipal Airport	851
ID, Boise	KCBX	Wild Horse Corral, Ada City	3,171
ID, Pocatello	KSFX	Springfield, ID	4,539
IL, Lincoln	KILX	Logan County Airport: Lincoln, IL	730
IL, Chicago	KLOT	Romeoville, IL	760
IN, Evansville	KVWX	Owensville, IN**	624
IN, Indianapolis	KIND	Indianapolis Intl. Airport	887
IN, Northern IN	KIWX	North Webster, IN	1,056
KS, Dodge City	KDDC	Dodge County Regional Airport	2,671
KS, Goodland	KGLD	Goodland, KS	3,716
KS, Topeka	KTWX	Alma, KS	1,415
KS, Wichita	KICT	Wichita Mid-Continental Airport	1,400
KY, Jackson	KJKL	Jackson, KY	1,462
KY, Louisville	KLVX	Fort Knox Military Reservation	833
KY, Paducah	KPAH	Barkley Regional Airport	506
LA, Lake Charles	KLCH	Lake Charles Regional Airport	137
LA, Slidell	KLIX	Slidell Airport	179
LA, Shreveport	KSHV	Shreveport Regional Airport	387
MA, Boston	KBOX	Taunton, MA	232
ME, Caribou	KCBW	Houlton, ME	860
ME, Portland	KGYX	Gray, ME	474
MI, Detroit	KDTX	White Lake, MI	1,216

** - Evansville MSCF at Paducah, KY WFO

TABLE 3-1
NETWORK SITES

Metropolitan Area	Radar ICAO	RDA System Location	Antenna Elev. (Ft) MSL
MI, Grand Rapids	KGRR	Kent County Intl. Airport	875
MI, Marquette	KMQT	Negaunee, MI	1,525
MI, N. Cent. Lower-MI	KAPX	Gaylord, MI	1,562
MN, Duluth	KDLH	Duluth, MN	1,542
MN, Minneapolis	KMPX	Chanhassen, MN	1,101
MO, Pleasant Hill	KEAX	Pleasant Hill, MO	1,093
MO, Springfield	KSGF	Springfield Regional Airport	1,375
MO, St. Louis	KLSX	Weldon Spring, MO	722
MS, Jackson	KDGX	Brandon, MS	609
MT, Billings	KBLX	Yellowstone County, MT	3,702
MT, Glasgow	KGGW	Valley County Intl. Airport	2,384
MT, Great Falls	KTFX	Great Falls, MT	3,779
MT, Missoula	KMSX*	Point Six Mtn., MT	7,904
NC, Morehead City	KMHX	Newport, NC	145
NC, Raleigh/Durham	KRAX	Clayton, NC	462
NC, Wilmington	KLTX	Shallotte, NC	145
ND, Bismarck	KBIS	Bismarck Muncpl. Airport	1,756
ND, Grand Forks/Fargo	KMVX	Mayville, ND	1,083
NE, Grand Island	KUEX	Blue Hill, NE	2,057
NE, North Platte	KLNX	County Airport Thedford, NE	3,068
NE, Omaha	KOAX	Valley, NE	1,262
NM, Albuquerque	KABX	Albuquerque, NM	5,951
NV, Elko	KLRX *	Elko, NV	6,858
NV, Las Vegas	KESX	Opal Mtn: Nelson, NV	4,948

* - Redundant RDA

TABLE 3-1
NETWORK SITES

Metropolitan Area	Radar ICAO	RDA System Location	Antenna Elev. (Ft) MSL
NV, Reno	KRGX*	Nixon, NV	8,397
NY, Albany	KENX	East Berne, NY	1,907
NY, Binghamton	KBGM	Binghamton Reg. Airport	1,704
NY, Buffalo	KBUF	Greater Buffalo Intl. Airport	790
NY, Brookhaven	KOKX	Upton, NY	199
OH, Cincinnati	KILN	Wilmington, OH	1,170
OH, Cleveland	KCLE	Cleveland-Hopkins Airport	860
OK, Norman	KTLX	Midwest City, OK	1,278
OK, Tulsa	KINX	Inola, OK	749
OR, Medford	KMAX*	Mount Ashland, OR	7,561
OR, Pendleton	KPDT	Eastern Oregon Regional Airport	1,580
OR, Portland	KRTX	Scappoose, OR	1,686
PA, State College	KCCX	State College, PA	2,486
PA, Philadelphia	KDIX	Fort Dix: Manchester, NJ	230
PA, Pittsburgh	KPBZ	Coraopolis, PA	1,266
SC, Charleston	KCLX	Grays, SC	229
SC, Columbia	KCAE	Columbia Metropolitan Airport	345
SC, Greer	KGSP	Greenville-Sprtb Airport: Greer, SC	1,068
SD, Aberdeen	KABR	Aberdeen Regional Airport	1,383
SD, Rapid City	KUDX	New Underwood, SD	3,194
SD, Sioux Falls	KFSD	Sioux Falls, SD	1,495
TN, Knoxville/TriCities	KMRX	Morristown, TN	1,435
TN, Memphis	KNQA	Millington Naval Air Station, TN	435
TN, Nashville	KOHX	Old Hickory, TN	676

* - Redundant RDA

TABLE 3-1
NETWORK SITES

Metropolitan Area	Radar ICAO	RDA System Location	Antenna Elev. (Ft) MSL
TX, Amarillo	KAMA	Amarillo International Airport	3,702
TX, Austin/San Antonio	KEWX	New Braunfels Muncpl. Airport	767
TX, Brownsville	KBRO	Brwnsvl/S.Padre Is. Intl. Airport	88
TX, Corpus Christi	KCRP	Corpus Christi Intl. Airport	142
TX, Dallas/Fort Worth	KFWS	Fort Worth, TX	764
TX, El Paso	KEPZ	County Airport SantaTeresa, NM	4,218
TX, Houston/Galveston	KHGX	Dickinson, TX	115
TX, Lubbock	KLBB	Lubbock Intl. Airport	3,340
TX, Midland/Odessa	KMAF	Midland Intl. Airport	2,961
TX, San Angelo	KSJT	Mathis Field: San Angelo, TX	2,004
UT, Cedar City	KICX *	Blowhard Mtn: Iron County **	10,754
UT, Salt Lake City	KMTX*	Promontory Pt: Box Elder County	6,574
VA, Sterling	KLWX	Sterling R&D Center: Sterling, VA	369
VA, Roanoke	KFCX	Coles Knob Floyd County	2,966
VA, Norfolk	KAKQ	Wakefield, VA	209
VT, Burlington	KCXX	Colchester, VT	431
WA, Seattle/Tacoma	KATX	Everett, WA	608
WA, Spokane	KOTX	Spokane, WA	2,449
WI, Green Bay	KGRB	Green Bay, WI	806
WI, La Crosse	KARX	La Crosse, WI	1,357
WI, Milwaukee	KMKX	Dousman, WI	1,023
WV, Charleston	KRLX	Ruthdale, WV	1,194
WY, Cheyenne	KCYS	Cheyenne, WY	6,193
WY, Riverton/Lander	KRIW	Riverton Regional Airport	5,633

* - Redundant RDA; ** - Cedar City MSCF at Salt Lake City, UT WFO

TABLE 3-2
SUPPLEMENTAL SITES

Coverage Area	Radar ICAO	RDA System Location	MSCF Location	Antenna Elev. (Ft) MSL
AL, Maxwell AFB	KMXX	Carrville, AL	WFO at Birmingham, AL	560
AL, Fort Rucker	KEOX	Echo, AL	WFO at Tallahassee, FL	537
CA, Beale AFB	KBBX	Oroville, CA	WFO at Sacramento, CA	221
CA, Edwards AFB	KEYX	Boron, CA	WFO at Las Vegas, NV	2,872
CA, Vandenberg AFB	KVBX	Orcutt, CA	Vandenberg AFB, CA	1,354
DE, Dover AFB	KDOX	Ellendale, DE	WFO at Wakefield, VA	164
FL, Eglin AFB	KEVX	Red Bay, FL	WFO at Mobile, AL	221
GA, Moody AFB	KVAX	South Stockton, GA	WFO at Jacksonville, FL	330
GA, Robins AFB	KJGX	Jeffersonville, GA	WFO at Atlanta/Peachtree City, GA	618
KY, Fort Campbell	KHPX	Trenton, KY	WFO at Paducah, KY	624
LA, Fort Polk	KPOE	Fort Polk, LA	WFO at Lake Charles, LA	473
MS, Columbus AFB	KGWX	Greenwood Springs, MS	WFO at Jackson, MS	589
ND, Minot AFB	KMBX	Deering, ND	WFO at Bismarck, ND	1,591
NM, Cannon AFB	KFDX	Field Village, NM	WFO at Albuquerque, NM	4,698
NM, Holloman AFB	KHDX	Ruidoso, NM	WFO at El Paso, TX	4,270
NY, Fort Drum	KTYX	Montague, NY	WFO at Burlington, VT	1,960
OK, Altus AFB	KFDR	Frederick, OK	WFO at Norman, OK	1,315
OK, Vance AFB	KVNX	Cherokee, OK	WFO at Norman, OK	1,258
TX, Ft. Hood	KGRK	Granger, TX	WFO at Fort Worth, TX	603
TX, Dyess AFB	KDYX	Moran, TX	WFO at San Angelo, TX	1,582
TX, Laughlin AFB	KDFX	Brackettville, TX	WFO at Austin/San Antonio, TX	1,196

TABLE 3-3
DOT NON-CONUS SITES

Metropolitan Area	Radar ICAO	RDA System Location	MSCF Location	Antenna Elev. (Ft) MSL
AK, Anchorage	PAHG*	Kenai, AK	WFO at Anchorage, AK	356
AK, Bethel	PABC*	Bethel, AK	WFO at Anchorage, AK	193
AK, Fairbanks	PAPD*	Pedro Dome, AK	WFO at Fairbanks, AK	2,707
AK, Sitka	PACG*	Biorka Island, AK	WFO at Juneau, AK	272
AK, King Salmon	PAKC*	King Salmon, AK	WFO at Anchorage, AK	144
AK, Middleton Island	PAIH*	Middleton Island, AK	WFO at Anchorage, AK	142
AK, Nome	PAEC*	Beam Road: Nome, AK	WFO at Fairbanks, AK	90
HI, Kamuela/Kohala	PHKM*	Kamuela, HI	WFO at Honolulu, HI	3,965
HI, Molokai	PHMO*	Kukui Amikopala: Molokai, HI	WFO at Honolulu, HI	1,444
HI, South Shore	PHWA*	Naalehu, HI	WFO at Honolulu, HI	1,461
HI, South Kauai	PHKI*	Kauai Coffee Company: Numila, HI	WFO at Honolulu, HI	340
PR, San Juan	TJUA*	Vereda Los Baldios: Cayey, PR	WFO at San Juan, PR	2,958

* All sites have a redundant RDA and RPG

TABLE 3-4
DoD NON-CONUS SITES

Metropolitan Area	Radar ICAO	RDA System Location	MSCF Location	Antenna Elev. (Ft) MSL
GUAM, Andersen AFB	PGUA	Barrigada Communication Facility	Guam WFO	378
JAPAN, Kadena AB	RODN	Okinawa, Japan: White Beach	Hickam AFB, HI	332
PORTUGAL, Lajes AB	LPLA	Santa Barabara Mtn, Isl. of Terceira	Lajes AB	3,415
SOUTH KOREA, Camp Humphreys	RKSG	Camp Humphreys, ROK	Hickam AFB, HI	133
SOUTH KOREA, Kunsan AB	RKJK	Kunsan Air Base: Radio Relay Hill	Hickam AFB, HI	192

TABLE 3-5
CALCULATION OF ANTENNA ELEVATION

Antenna   ANTENNA ELEVATION (Feet): The elevation of the center of the WSR-88D
Elev. (Ft)   antenna is expressed in feet above mean sea level (MSL). It is the sum of the antenna's center-point height above ground level (AGL) and the RDA site's terrain elevation.

For example, the WSR-88D antenna elevation for San Diego (KNKX) is;

    a.   Antenna height (AGL)   =   RDA Tower + Antenna Pedestal Height.

    b.   Antenna height (AGL)   =   25.0 m + 4.7 m   =   29.7 m.

    c.   Antenna height (AGL)   =   (29.7 m)   x   3.28 ft / m   =   97.4 ft [Round to 97].

    d.   Antenna Elevation (MSL)   =   Antenna Height + RDA Elevation.

    e.   Antenna Elevation (MSL)   =   97 ft + 955 ft   =   1,052 ft MSL.

Values for the RDA site elevation and RDA tower height come from the National Implementation Staff Site Reference Book. The value for antenna pedestal height was provided by the ROC.

CHAPTER 4

OPERATIONAL MODES, VOLUME COVERAGE PATTERNS, AND PRODUCTS

4.1 <u>Introduction</u>. This chapter outlines the WSR-88D operational modes [1], volume coverage patterns (VCPs) [2], and the full suite of WSR-88D products that may be generated.

4.2 <u>Operational Modes</u>. Two operational modes have been implemented: Clear Air and Precipitation. Each mode has one generation list and at least two VCPs. Selection of the operational mode is closely related to the detected coverage of precipitation. The Mode Selection Function (MSF) is designed to automatically determine if precipitation is occurring within 230 km (124 nm) of the radar. The MSF examines the area of reflectivity returns at a specified intensity (above the Mode Reflectivity Threshold) and compares it to the Mode Areal Coverage Threshold in the Mode Selection Threshold Table. "Area of reflectivity returns" refers to base reflectivity without regard to ground clutter or other non-precipitation returns.

Automatic switching from Clear Air Mode to Precipitation Mode and from Precipitation Mode to Clear Air Mode is operator-controlled based on URC agreement. If Clear Air Mode switching is manual and Precipitation switching is automatic, the radar mode switching will operate as it did before Build 8. The Mode Reflectivity Threshold, Mode Areal Coverage Threshold, and Clear Air Mode Time Delay adaptable parameters, as well as toggle settings for the two manual/automatic mode switches, have URC level of change authority, and the routine practice of adjusting them will be based on URC agreement. Precipitation accumulation estimates are independent of the operational mode. [3]

      4.2.1 Mode A -- Precipitation Mode (VCPs 11, 12, 21, and 121). This mode should be used when significant weather echoes are present or severe weather is occurring or is anticipated. Usually, this mode will have been selected automatically due to the detection of reflectivity exceeding the Mode Reflectivity Threshold over an area exceeding the Mode Areal Coverage Threshold. At times, however, such as during the early, mid-level formation of convective echoes, the RPG Human-Computer Interface (HCI) operator may choose to enter the Precipitation Mode manually.

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[1] Operational Mode -- A combination of one or more VCPs and product lists designed to better observe one or more features in a given meteorological environment.

[2] VCP -- An automated method that repetitively scans the atmosphere through a sequence of predefined elevation angles, antenna rotation rates, and pulse characteristics. A sequence of scans is called a volume scan. Table 4-1 provides the characteristics for each VCP.

[3] The Precipitation Processing Subsystem (PPS) algorithms use settings internal to the PPS that assess rainfall areas from the assembled Hybrid Scan to determine start/stop times of distinct precipitation events.

TABLE 4-1
VOLUME COVERAGE PATTERN DESCRIPTION

Volume Coverage Pattern Number	Number Of Azimuthal Scans	Number Of Different Elevation Angles	Time To Complete (Minutes)
11	16	14	5
12	17	14	4.2
21	11	9	6
31	7	5	10
32	7	5	10
121	20	9	5.5

4.2.2 Mode B – Clear Air Mode (VCPs 31 and 32). This mode may be used when there is no detectable precipitation or when precipitation intensity and areal extent are small. The RPG software will not allow a change to Clear Air Mode until precipitation exceeding the designated thresholds has not been detected for the period specified in the Clear Air Mode Time Delay.

4.3 <u>Volume Coverage Patterns</u>. During operations, the antenna is controlled by automatic scanning programs. Volume coverage patterns are matched to an operational mode to optimize product generation for given meteorological situations; the various VCPs are further defined in Chapter 5, Part C of this Handbook. In each operational mode, scanning is continuous. Principal users are informed of the radar operational mode and the VCP in use through system status messages.

4.3.1 Volume Coverage Patterns 31 and 32. Both of these VCPs are used in the Clear Air Mode to optimize the sensitivity of the WSR-88D. The VCP 31 (long pulse) provides a better signal-to-noise ratio permitting lower reflectivity returns to be detected, while VCP 32 (short pulse) provides a higher unambiguous velocity.

4.3.2 Volume Coverage Patterns 11 and 21. These VCPs are used in the Precipitation Mode to better sample the vertical structure of convective weather echoes and to provide better temporal resolution. The VCP 11 provides better vertical sampling of weather echoes near the antenna than VCP 21 and is usually preferred in situations where convective precipitation is within 60 nm of the antenna.

4.3.3 Volume Coverage Pattern 12. This VCP has the same number of elevation angles as VCP 11. However, denser vertical sampling at lower elevation angles provides better vertical definition of storms, improve detection capability of radars impacted by terrain blockage for

better rainfall and snowfall estimates, result in more storms being identified, and provide quicker updates.

4.3.4. Volume Coverage Pattern 121. This VCP has the same elevation angles as VCP 21, but more scans. This VCP implements the Multi-Pulse Repetition Frequency Dealiasing Algorithm (MPDA) which helps mitigate range/velocity aliasing (the Doppler Dilemma).

4.4 WSR-88D Product Suite. Table 4-2 provides brief descriptions of every WSR-88D product. Products are initiated for generation through one of several means: through the RPG Product Generation Table, Routine Product Set lists, alert-product pairing, and through one-time requests from associated users. The specific products that constitute the baseline Product Suite for each weather mode are defined in the *WSR-88D Operator Handbook, Guidance on Adaptable Parameters - RPG*. The products listed in Table 4-2 are current as of RPG software Build 8 (May 2006 release).

TABLE 4-2
PRODUCT DESCRIPTION

PROD ID	PROD NUM	DATA LEVELS	COVERAGE (nm)	RESOLUTION (nm or see key)	PRODUCT NAME AND DESCRIPTION
R	16	8	0 – 124	0.54 x 1°	Reflectivity.
R	17	8	0 – 248	1.1 x 1 °	Reflectivity.
R	18	8	0 – 248	2.2 x 1 °	Reflectivity.
R	19	16	0 – 124	0.54 x 1 °	Reflectivity.
R	20	16	0 – 248	1.1 x 1 °	Reflectivity.
R	21	16	0 – 248	2.2 x 1 °	Reflectivity.
V	22	8	0 – 32	0.13 x 1 °	Mean Radial Velocity.
V	23	8	0 – 62	0.27 x 1 °	Mean Radial Velocity.
V	24	8	0 – 124	0.54 x 1 °	Mean Radial Velocity.
V	25	16	0 – 32	0.13 x 1 °	Mean Radial Velocity.
V	26	16	0 – 62	0.27 x 1 °	Mean Radial Velocity.
V	27	16	0 – 124	0.54 x 1 °	Mean Radial Velocity.
SW	28	8	0 – 32	0.13 x 1 °	Spectrum Width.
SW	29	8	0 – 62	0.27 x 1 °	Spectrum Width.
SW	30	8	0 – 124	0.54 x 1 °	Spectrum Width.
USP	31	16	0 – 124	1.1 x 1 °	User Selectable Rainfall Accumulation.
DHR	32	256	0 – 124	0.54 x 1 °	Digital Hybrid Scan Reflectivity.
HSR	33	16	0 – 124	0.54 x 1 °	Hybrid Scan Reflectivity.
CFC	34	8	0 – 124	0.54 x 1.4 °	Clutter Filter Control. Generated when clutter suppression definition changes.
CR	35	8	0 – 124	0.54 x 0.54	Composite Reflectivity.

TABLE 4-2
PRODUCT DESCRIPTION

PROD ID	PROD NUM	DATA LEVELS	COVERAGE (nm)	RESOLUTION (nm or see key)	PRODUCT NAME AND DESCRIPTION
CR	36	8	0 – 248	2.2 x 2.2	Composite Reflectivity.
CR	37	16	0 – 124	0.54 x 0.54	Composite Reflectivity.
CR	38	16	0 – 248	2.2 x 2.2	Composite Reflectivity.
ET	41	16	0 – 124	2.2 x 2.2	Echo Tops. Min=5,000 ft, Max=70,000 ft MSL.
SWR	43	16	0 – 124	0.54 x 1 °	Severe Weather Analysis - Reflectivity. Presentation area is 27 nm x 27 nm and is centered on: (a) alerting phenomenon or, (b) user selected coordinates.
SWV	44	16	0 – 124	0.13 x 1 °	Severe Weather Analysis –Mean Radial Velocity. See SWR (PROD ID #43) description.
SWW	45	16	0 – 124	0.13 x 1 °	Severe Weather Analysis - Spectrum Width. See SWR (PROD ID# 43) description.
SWS	46	16	0 – 124	0.27 x 1 °	Severe Weather Analysis - Radial Shear. See SWR (PROD ID #43) description, above.
SWP	47	4	0 – 124	2.2 x 2.2	Severe Weather Probability. Default presentation 'box' is 15.1 nm x 15.1 nm.
VWP	48	30	16 (default value)	1,000 ft (z)	VAD Wind Profile. Barbs show speeds to nearest 5 kt. Height (every 1000 ft) is plotted on z-axis and time (up to 11 volume scans) is plotted on x-axis.
RCS	50	16	0 – 124	0.54 x 0.27(z)	Cross Section -- Reflectivity. Min=0 ft, Max=70,000 ft MSL.
VCS	51	16	0 – 124	0.54 x 0.27(z)	Cross Section – Mean Radial Velocity. Min=0 ft, Max=70,000 ft MSL.

z = vertical

TABLE 4-2
PRODUCT DESCRIPTION

PROD ID	PROD NUM	DATA LEVELS	COVERAGE (nm)	RESOLUTION (nm or see key)	PRODUCT NAME AND DESCRIPTION
SRR	55	16	0 – 124	0.27 x 1 °	Storm Relative Mean Radial Velocity--Region. See notes for SRM (PROD ID #56), below. The presentation area is 27 nm x 27 nm centered on operator-defined location.
SRM	56	16	0 – 124	0.54 x 1 °	Storm Relative Mean Radial Velocity--Map. Derived from vector average of all identified storms or vector input by operator. Presentation area is 0 - 124 nm.
VIL	57	16	0 – 124	2.2 x 2.2	Vertically Integrated Liquid Water.
STI	58	n-a	0 – 186	n-a	Storm Tracking Information. Graphic product with 15 minute position intervals.
HI	59	5	0 – 124	n-a	Hail Index. Includes overlay to show probability and max hail size per storm.
M	60	3	0 – 124	n-a	Mesocyclone. Includes overlay for identified storms' data.
TVS	61	n-a	0 – 124	n-a	Tornado Vortex Signature. Includes overlay for identified storms' data.
SS	62	n-a	0 – 248	n-a	Storm Structure. Table generated each VCP.
LRA	63	8	248 x 248	2.2 x 2.2	Layer Composite Reflectivity – Average. Low Layer.
LRA	64	8	248 x 248	2.2 x 2.2	Layer Composite Reflectivity-- Average. Mid Layer.
LRM	65	8	124 x 124	2.2 x 2.2	Layer Composite Reflectivity-- Maximum. Low Layer.
LRM	66	8	124 x 124	2.2 x 2.2	Layer Composite Reflectivity-- Maximum. Mid Layer.

n-a = not applicable

TABLE 4-2
PRODUCT DESCRIPTION

PROD ID	PROD NUM	DATA LEVELS	COVERAGE (nm)	RESOLUTION (nm or see key)	PRODUCT NAME AND DESCRIPTION
APR	67	8	124 x 124	2.2 x 2.2	Layer Composite Reflectivity–AP Removed. Low Layer.
UAM	73	n-a	n-a	n-a	User Alert Message. Generated upon alert activation.
RCM	74	9	0 – 248	1/16 x 1/16 LFM	Radar Coded Message. Generated near HH:20 and HH:50 UTC. Derived from the IRM product.
FTM	75	n-a	n-a	n-a	Free Text Message. Messages can be generated at MSCF and RPG.
OHP	78	16	0 – 124	1.1 x 1 °	One-Hour Rainfall Accumulation.
THP	79	16	0 – 124	1.1 x 1 °	Three-Hour Rainfall Accumulation.
STP	80	16	0 – 124	1.1 x 1 °	Storm Total Rainfall Accumulation.
DPA	81	256	0 – 124	1/40 x 1/40 LFM	Hourly Digital Precipitation Array.
SPD	82	n-a	n–a	n-a	Supplemental Precipitation Data. Alphanumeric with rain gage values and times.
VAD	84	8	16 (default value)	n-a	Velocity Azimuth Display. Product is available for altitudes specified by VWP product (PROD ID #48).
RCS	85	8	0 – 124	0.54 x 0.27(z)	Cross Section -- Reflectivity.
VCS	86	8	0 – 124	0.54 x 0.27(z)	Cross Section – Mean Radial Velocity.
CS	87	16	124 x 124	'adaptable'	Combined Shear.
LRA	89	8	248 x 248	2.2 x 2.2	Layer Composite Reflectivity-- Average. High Layer.

n-a = not applicable

TABLE 4-2
PRODUCT DESCRIPTION

PROD ID	PROD NUM	DATA LEVELS	COVERAGE (nm)	RESOLUTION (nm or see key)	PRODUCT NAME AND DESCRIPTION
LRM	90	8	124 x 124	2.2 x 2.2	Layer Composite Reflectivity-- Maximum. High Layer.
DBV	93	256	lesser of 62 nm or18 kft AGL	0.54 x 1 °	Integrated Terminal Weather System Digital Base Velocity.
DR	94	256	0 – 248	0.54 x 1 °	Base Reflectivity Data Array.
CRE	95	8	0 – 124	0.54 x 0.54	Composite Reflectivity Edited for Anomalous Propagation.
CRE	96	8	0 – 248	2.2 x 2.2	Composite Reflectivity Edited for Anomalous Propagation.
CRE	97	16	0 – 124	0.54 x 0.54	Composite Reflectivity Edited for Anomalous Propagation.
CRE	98	16	0 – 248	2.2 x 2.2	Composite Reflectivity Edited for Anomalous Propagation.
DV	99	256	0 – 124	0.13 x 1 °	Base Velocity Data Array.
CLR	132	11	0 – 124	0.54 x 1 °	Clutter Likelihood Reflectivity.
CLD	133	12	0 – 124	0.54 x 1 °	Clutter Likelihood Doppler.
DVL	134	256	0 – 248	0.54 x 1 °	High Resolution Digital Vertically Integrated Liquid.
EET	135	199	0 – 186	0.54 x 1 °	High Resolution Enhanced Echo Tops.
SO	136	n-a	0 - 124	n-a	SuperOb: National Centers for Environmental Prediction Winds Model Initialization.
ULR	137	16	0 – 124	0.54 x 1 °	User Selectable Layer Composite Reflectivity.
DSP	138	256	0 – 124	1.1 x 1 °	Storm Total Rainfall Accumulation (Digital Storm Product).

n-a = not applicable

TABLE 4-2
PRODUCT DESCRIPTION

PROD ID	PROD NUM	DATA LEVELS	COVERAGE (nm)	RESOLUTION (nm or see key)	PRODUCT NAME AND DESCRIPTION
MRU	139	3	0 – 124	n-a	Mesocyclone Rapid Update.
MD	141	3	0 – 124	n-a	Mesocyclone Detection.
TRU	143	n-a	0 – 124	n-a	Tornado Vortex Signature Rapid Update.
OSW	144	16	0 – 124	0.54 x 1 °	One-Hour Snow Water Equivalent Accumulation.
OSD	145	16	0 – 124	0.54 x 1 °	One-Hour Snow Depth Accumulation.
SSW	146	16	0 – 124	0.54 x 1 °	Storm Total Snow Water Equivalent Accumulation.
SSD	147	16	0 – 124	0.54 x 1 °	Storm Total Snow Depth Accumulation.
DMD	149	3	0 – 124	n-a	Digital Mesocyclone Detection Data Array.
USW	150	16	0 – 124	0.54 x 1 °	User Selectable Snow Water Equivalent Accumulation.
USD	151	16	0 – 124	0.54 x 1 °	User Selectable Snow Depth Accumulation.
ASP	152	n-a	n-a	n-a	Archive III Status Product. Collected Every 8 Hours, Beginning at 00:00 UTC.

n-a = not applicable

z = vertical

KEY FOR TABLE 4-2

PROD ID	PRODUCT IDENTIFIER: The official one, two, or three letter abbreviations used by the WSR-88D system and displayed on WSR-88D products.
PROD NUM	PRODUCT NUMBER: The official identification number assigned to WSR-88D products. Product numbers are recognized by the WSR-88D system software.
DATA LEVLS	DATA LEVELS: The number of gradations that display the magnitude of data in a color indexed graphical format. Some alphanumeric products have multiple categories of information (e.g., severe weather probability). The number of categories is expressed as the number of data levels.
COVERAGE	RANGE OF COVERAGE: The geographical scope of coverage for a given product. There are three types of product formats; polar, Cartesian, and grid-based. The areal extent for polar and grid-based products is indicated with a polar range limit (e.g., 460 km (248 nm)). Cartesian products' aerial extent is described by x-axis and y-axis lengths (e.g., 230 km x 230 km (124 nm x 124 nm)).
RESOLUTION	DATA RESOLUTION: Standard units of measure describe the size of the products' discrete data elements. The type of units used (e.g., nm, arc degree, grid fraction) is a function of a product's format. Product formats are: polar, Cartesian, and grid-based. The limited-area fine mesh (LFM) grid is a standard reference for the radar coded message products.
1/40 L: Approximately 2.2 nm x 2.2 nm. The 2.2 nm length is 1/40 of the LFM grid-point separation. **1/16 L:** Approximately 5.4 nm x 5.4 nm. The 5.4 nm length is 1/16 of the LFM grid-point separation. **1/4 L:** Approximately 22 nm x 22 nm. The 22 nm length is 1/4 of the LFM grid-point separation.	
PRODUCT NAME AND DESCRIPTION	The full name of product followed by pertinent information.

CHAPTER 5

ARCHIVING

5.1 <u>**Introduction.**</u> The WSR-88D system has the capability to provide for the archiving of data and products at four functional locations. The locations are identified as Archive Levels I, II, III, and IV, respectively. The following sections, exclusive of the final section, provide a brief description of each level and potential utilization of data archived at each level. The final section provides information pertaining to product retention at NOAA's National Climatic Data Center (NCDC).

5.2 <u>**Archive Level I.**</u> The Archive Level I interface is located at the RDA. Data available are the analog, time-domain output of the receiver. Information regarding synchronization, calibration, date, time, antenna position, and status is also available at this level. However, Archive Level I data are not used operationally. Archive Level I data are used for RDA system diagnostics and input for signal processor optimization studies.

5.3 <u>**Archive Level II.**</u> Archive Level II data are the digital base data output from the signal processor. The output also includes status information required to properly interpret the data (e.g., information on synchronization, calibration, date, time, antenna position, clutter and notchwidth maps, operational mode). Archive Level II data are used for many purposes including: support of operational, maintenance and developmental activities at the ROC; activities directed toward algorithm and product enhancement; and research by universities. The only Level II data archived are those sent to the NCDC by the NWS WSR-88D Level II Central Collection and Distribution Network (Section 2.4.2).

5.4 <u>**Archive Level III**</u>. Archive Level III data are the output of the RPG. Archive Level III data are continuously transmitted from DOC WSR-88D systems to the NCDC via the AWIPS and the RPCCDS. Sites currently send products beyond the list of Level III products to the RPCCDS and NCDC (Section 2.4.1).

5.5 <u>**Archive Level IV.**</u> Archive Level IV data are the output data of the RPG. The Archive Level IV interface is located at the Principal User Processor/Open Systems Principal User Processor (PUP/OPUP). All DoD sites with a PUP/OPUP will perform Archive Level IV archiving for local training, studies, accident investigation, and other purposes as required. At NWS sites, the AWIPS has an Archive Level IV-like capability.

5.6 <u>Retention by National Climatic Data Center.</u> Archive Level II and Archive Level III data are sent to the NCDC for permanent retention. The NCDC receives, archives, and makes these products and data available upon request. Information on the WSR-88D data in the NCDC archives can be found at: http://www.ncdc.noaa.gov/oa/radar/radarresources.html.

CHAPTER 6

ADAPTABLE PARAMETER CHANGE AUTHORITY

6.1 <u>Introduction.</u> The WSR-88D's design includes thousands of parameters that permit each WSR-88D system to be adapted to certain geographical and meteorological conditions to support operational requirements. Since the WSR-88D is operated to satisfy the integrated needs of the principal users and to support the national radar network, centralized control of many of the system and meteorological parameters is required to ensure a baseline operational standard. However, a subset of these parameters was designed specifically to address the local operational needs. For this reason the principal user agencies agreed to categorize a number of WSR-88D adaptable parameters into three levels of change authority (LOCA) as defined in Section 6.2. This was done, primarily, to ensure the proper LOCA use of these adaptable parameters. As defined, each of these three LOCA categories permits the modification of WSR-88D hardware and software through a controlled process.

Official guidance on WSR-88D adaptable parameters is documented by the *WSR-88D Operator Handbook, Guidance on Adaptable Parameters, Volumes II-IV*. RPG parameters are comprehensively categorized by their LOCA in Volume IV, PUP parameters are comprehensively enumerated in Volume II, and RDA system parameters are covered in Volume III. Volumes II and IV discuss the default and alternate settings that optimize the control of algorithms and the quality of WSR-88D products and communications.

6.2 <u>Levels of Change Authority.</u> The adaptable parameters have been grouped according to the level of approval that is necessary before the parameter's value can be changed. These groupings are intended to give maximum flexibility in operational use of the WSR-88D while ensuring that agency operations are not jeopardized and the system remains stable.

 6.2.1 Radar Operations Center. Through the Adaptable Parameter Working Group (APWG), the ROC shall determine the general validity and range of adaptable parameter values for changes that affect the technical and scientific characteristics of WSR-88D data acquisition and algorithmic processing. In addition, the ROC shall be authorized to determine, specifically, the values for the aforementioned default adaptable parameter values for WSR-88D equipment owned by the DoD, DOT, and the DOC. Since the APWG shall remain subordinate to the NPMC, the ROC level of change authority shall reflect the NPMC's position on triagency policy in WSR-88D operations.

 6.2.2 Unit Radar Committee. Each URC shall be authorized to change their WSR-88D system's adaptable parameter values and establish adaptation parameter policy for the principal users within the URC. Types of changes that a single URC is authorized to implement shall include the "fine-tuning" needed to meet local operational requirements, seasonal changes, and local climatological characteristics.

6.2.3 Agency. The agency is the principal user agency (DOC, DoD, or DOT) that controls the involved hardware and software. Each agency is authorized to change the range of adaptable parameter values, change default values, and establish WSR-88D adaptable parameter policy in order to meet agency-specific mission requirements and criteria. Changes that a single agency are authorized to implement may involve user passwords, meteorological algorithm parameters, and certain telecommunications settings.

APPENDIX A

ACRONYMS AND ABBREVIATIONS

AB — Air Base
AFB — Air Force Base
AGL — Above Ground Level
AP — Anomalous Propagation
APWG — Adaptable Parameter Working Group
ARTCC — Air Route Traffic Control Center
AWIPS — Advanced Weather Interactive Processing System

CONUS — Conterminous United States

DOC — Department of Commerce
DoD — Department of Defense
DOT — Department of Transportation

Elev — Elevation

FAA — Federal Aviation Administration
FMH — Federal Meteorological Handbook
ft — Foot

HCI — Human Computer Interface

IA — Implementing Agreement
ICAO — International Civil Aviation Organization

kft — 1000s of feet

LFM — Limited Area Fine Mesh
LOCA — Level of Change Authority

m — Meter
MOA — Memorandum of Agreement
MPDA — Multi-Pulse Repetition Frequency Dealiasing Algorithm
MSCF — Master System Control Function
MSF — Mode Selection Function
MSL — Mean Sea Level

NCDC — National Climatic Data Center
NEXRAD — Next Generation Weather Radar
nm — Nautical Mile

NOAA   -   National Oceanic and Atmospheric Administration
NPC   -   NEXRAD Program Council
NPMC   -   NEXRAD Program Management Committee
NWS   -   National Weather Service

OFCM   -   Office of the Federal Coordinator for Meteorological Services and
                    Supporting Research
OPUP   -   Open System Principal User Processor

PPS   -   Precipitation Processing Subsystem
PUP   -   Principal User Processor

ROC   -   WSR-88D Radar Operations Center
RPCCDS   -   Radar Product Central Collection Dissemination Service
RPG   -   Radar Product Generator

URC   -   Unit Radar Committee
US   -   United States
UTC   -   Universal Time Coordinated

VAD   -   Velocity Azimuth Display
VCP   -   Volume Coverage Pattern

WARP   -   Weather and Radar Processor
WFO   -   Weather Forecast Office
WG/DRMO   -   Working Group for Doppler Radar Meteorological Observations
WSR-88D   -   Weather Surveillance Radar - 1988, Doppler

z   -   Vertical

APPENDIX B

GLOSSARY

Adaptable Parameter: Generally, data related to a specific WSR-88D system. These data may consist of meteorological or hydrological parameters or of geographic boundaries, political boundaries, system configuration, telephone numbers, or similar data. Such data may be generated at either a centralized location or locally.

Associated Principal User: A principal user linked to a WSR-88D system with a dedicated telecommunication line.

Base Data: Those digital fields of reflectivity, mean radial velocity, and spectrum width data in spherical coordinates provided at the finest resolution available from the radar.

Conterminous United States: Those states of the United States enclosed within one common boundary. The conterminous 48 states of the United States is abbreviated 'CONUS'.

Data Resolution: The resolution of the base data as produced by the signal processor, nominally 0.54 nm (1 km) x 1° in azimuth x 1° in elevation for reflectivity values and 0.13 nm (0.25 km) x 1° in azimuth x 1° in elevation for velocity values.

Default Value: A setting or value that will be used in a given software program unless changed.

Echoes: Areas of radar reflectivity visible in the WSR-88D products that may represent meteorological or non-meteorological phenomena.

Elevation Angle: The angle the WSR-88D antenna subtends to the horizontal plane. This value can vary from 0ºE to + 60ºE.

External User: Anyone other than a Principal User who has access to WSR-88D products (e.g., information service companies, broadcast meteorologists, aviation interests, industrial meteorologists, other government agencies, and universities).

Mesocyclone: A 3-dimensional region in a storm that rotates (usually cyclonically) and is closely correlated with severe weather.

National Weather Radar Network: Consists of WSR-88D sites dispersed throughout the CONUS.

Network Site: A DOC WSR-88D site in the CONUS that continuously collects, collates, and makes available radar data and products in support of the national weather radar network.

NEXRAD Program Council: Composed of a representative from each of the DOC, DoD, and DOT, and the Federal Coordinator for Meteorological Services and Supporting Research.

Non-Associated Principal User: A principal user with access to a WSR-88D system through means of dial telecommunication.

Non-Network Site: A non-CONUS DoD site or a non-CONUS DOT site.

Operational Mode: A combination of one or more volume coverage patterns and product lists designed to better represent one or more features in a given meteorological environment.

Principal User: Principal users are the NWS, Air Force, Marine Corps Weather Service units, and FAA.

NEXRAD Program Management Committee: A NEXRAD Program triagency organization comprised of representatives of DOC (NWS), DoD (Air Force Weather Agency), and DOT (FAA). Its responsibilities encompass all WSR-88D operational aspects (e.g., operations, maintenance, logistics, documentation, and training) to ensure that the common and unique agency concerns are addressed.

Radial Velocity: The component of motion of the target toward or away from the radar.

Reflectivity: The measure of the efficiency of a target in intercepting and returning radio energy. With hydrometeors it is a function of the drop size distribution, number of particles per unit volume, physical state (ice or water), shape, and aspect.

Spectrum Width: A measure of dispersion of velocities within the radar sample volume.

Supplemental Site: A DoD WSR-88D site in the CONUS. It continuously collects, collates, and makes available radar data and products in support of the DoD.

Tornado Vortex Signature: The radar signature of a vortex that is indicative of a tornado or tornadic circulation.

Unit Radar Committee: A coordinating committee, established by the MOA for Interagency Operation of the WSR-88D, composed of representatives of each principal user agency associated with a particular WSR-88D system.